First data on chigger mites (Acariformes: Trombiculidae) of Saudi Arabia, with a description of four new species

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Abstract
A collection of chigger mites from three species of rodents in the 'Asir Region of Saudi Arabia resulted in the finding of 19 species. Four new species are described: *Schoutedenichia asirensis* **sp. nov.,** *Schoutedenichia saudi* **sp. nov.,** *Microtrombicula microscuta* **sp. nov.,** and *Microtrombicula muhaylensis* **sp. nov.** Fifteen species – *Gahrliepia lawrencei* Jadin and Vercammen-Grandjean, 1952, *Schoengastiella wansoni* Wolfs and Vercammen-Grandjean, *Walchia parvula* Schluger, *Ascoschoengastia browni* Taufflieb, Mouchet and Courtois, *Helenicula lukshumiae* Nadchatram and Traub, *Schoutedenichia thracica* Kolebinova, *Schoutedenichia zarudnyi* Kudryashova, *Ericotrombidium caucasicum* (Schluger), *Ericotrombidium galliardi* (Vercammen-Grandjean and Taufflieb), *Ericotrombidium kazeruni* (Kudryashova), *Microtrombicula centropi* (Vercammen-Grandjean), *Microtrombicula hoogstraali* (Radford), *Microtrombicula hyracis* (Vercammen-Grandjean), *Microtrombicula traubi* (Muljarskaja and Verdieva), and *Pentidionis agamae* (André) – are for the first time recorded in Saudi Arabia and on new host species. Six of them are for the first time recorded outside their type localities and five were only known previously from the African continent.

Key words: chiggers, taxonomy, Western Asia, Arabian Peninsula, parasites of rodents

Introduction

Trombiculid mites (Acariformes: Trombiculidae) are a highly diverse, globally-distributed taxon that have attracted greater research efforts than many other acarine groups due to their medical and veterinary importance. The parasitic larval stage of these mites (known colloquially as "chiggers") are the sole vectors of scrub typhus, a severe febrile illness of humans caused by an obligate intracellular bacterium, *Orientia* spp., which is prevalent in the Asia-Pacific Region (Xu *et al.* 2017). Chiggers have also been implicated in the transmission of Hantaan virus (Yu and Tesh 2014), bartonellosis (Kabeya *et al.* 2010) and borreliosis (Kampen *et al.* 2004). Moreover, parasitism by chiggers has direct medical and veterinary impacts, as the feeding larvae can induce dermatitis (trombiculiasis) and potentially severe allergic reactions (Smith *et al.* 1998, Leone *et al.* 2013, Faccini *et al.* 2017).

Although taxonomic investigations of chigger mites have been rather extensive since the middle of the last century, little is known on the distribution of individual species. Among more than 3,500 chigger species described to the present (Zhang *et al.* 2011), only a small proportion was recorded outside their type localities. For example, 73% of African trombiculid species are known only from the type localities (Stekolnikov 2018). Large territories remain white spots as concerns the chigger fauna – in part, many African countries and almost the whole Arabian

Peninsula. These gaps in knowledge have become of considerable applied significance since reports of endemic scrub typhus and *Orientia*-infected chiggers have been published from the Arabian Peninsula and East Africa in recent years (Izzard *et al.* 2010, Masakhwe *et al.* 2018).

Among other groups of parasitic arthropods, the best studied in Saudi Arabia are fleas (Lewis 1982), ticks (Al-Khalifa *et al.* 2006, Diab *et al.* 2006) and mesostigmatic mites (Alatawi *et al.* 2018). No information on trombiculids of Saudi Arabia was known to the present. The only prior data on chigger distribution in the Arabian Peninsula were obtained by Radford (1954), who described nine species from Yemen, and by Stekolnikov *et al.* (2012) who found a new monotypic genus in Oman.

While Saudi Arabia is most famous for its deserts, particularly the Rub' al Khali or "Empty Quarter" of the south, the mountainous southwestern region of 'Asir is surprisingly lush, although its fauna of parasitic arthropods is poorly described. Our collections in this region generated a large number of chigger specimens that allowed us to contribute significantly to the knowledge of the chigger fauna of Western Asia.

Material and Methods

Rodents were trapped overnight using bread and peanut butter bait near the three villages: Al Ous' (18.27641, 42.320611; 1,594 m above sea level (a.s.l.)) in August 2016 and 2017, Wosanib (18.315641, 42.211478; 998 m a.s.l.) in August 2017 and Alogl (18.34654, 42.31654; 2,387 m a.s.l.) in July and August 2017. These villages are located between the towns of Muhayil Asir to the northwest and Abha to the southeast on the upper escarpment of the 'Asir Mountains. Two key biogeographical features nearby are the Jabal Sawdah peak (~3,000 m a.s.l.), approximately 10 km to the east/southeast, and the Raydah Sanctuary, 15 km to the southeast. The landscape consists of agricultural land and associated farmsteads, stony wadi beds, and rocky outcrops with scrubby vegetation (dominated by camphor bush, *Tarchonanthus camphoratus*; yielding to African juniper, *Juniperus procera*, at higher elevations) (Miyazaki *et al.* 2007).

The rodents were euthanized by inhaled anaesthetic overdose, then live chiggers were removed from predilection sites (ears, anus, the chin and back) using fine forceps under a dissecting microscope and fixed in 70% ethanol. Morphological identification of hosts was done in the field with the use of the book by Harrison and Bates (1991). To identify rodents molecularly, the tip of the tail was removed post-mortem and subjected to DNA extraction using a DNeasy Blood & Tissue Kit (Qiagen, Hilden, Germany) according to the manufacturer's instructions. A 307-bp fragment of the cytochrome *b* gene was amplified by conventional PCR using primers L14841 and H15149 (Kocher *et al.* 1989) and sequenced in both directions using the Sanger method (Eurofins Genomics GmbH, Ebersberg, Germany). Sequences were trimmed and aligned in BioEdit Sequence Alignment Editor (Hall 1999) and searched against the National Center for Biotechnology Information nucleotide databases using MegaBLAST (Altschul *et al.* 1990). The data were deposited in the Barcode of Life Data Systems (BOLD) (http://www.boldsystems.org), project code SSS.

The fixed chiggers were "relaxed" in water for two hours to reverse clasping of the legs around the body. Berlese fluid (TCS Bioscience Ltd, Buckingham, UK) was used to clear the specimens and they were mounted semi-permanently on glass slides in this medium. The prepared slides were incubated for two days at 50°C in a hot air incubator before microscopic examination, which was performed on a Leica DM5000B microscope (Leica Microsystems GmbH, Wetzlar, Germany) using differential interference contrast. Microphotographs were taken by means of the same microscope using a ToupCam 5.1 digital camera, model FMA050 (Hangzhou ToupTek Photonics Co., Ltd, Hangzhou, Zhejiang, China). Images of scuta (Figs 1, 3, 30, and 48) were created by merging serial microphotographs with the use of Adobe Photoshop CS3 software (Adobe Inc., San Jose, CA, US). Measurements were made with an ocular micrometer; morphological drawings (including figures of idiosomal setae arrangement that are need for an exact counting of setae) were prepared using a camera lucida. Measurements

and drawings were prepared with the use of a microscope MBI-3 (LOMO plc, St. Petersburg, Russia) using phase contrast optics.

We have used the standard terminology, abbreviations and diagnostic formulae generally accepted in the taxonomy of trombiculids (Goff *et al.* 1982, Stekolnikov 2018). The terms are also supplied with their equivalents in the common terminology for Prostigmata that is used in some recent papers on chigger taxonomy (Wohltmann *et al.* 2007, Jacinavicius *et al.* 2018). Intervals of variation are bracketed in the formulae of the arrangement of dorsal idiosomal setae (fD); plus signs (+) separate the total number of caudal setae if they cannot be divided into rows. In the schemes of the dorsal idiosomal setae arrangement (Figs 6, 16, 32, and 50), tentative bounds between rows of setae are outlined by dotted lines. In figures of the legs, double circles represent the bases of non-specialized setae; single circles correspond to the non-specialized setae situated at the opposite side of the leg.

Identification of chiggers was carried out on the base of a checklist of African trombiculid species (Stekolnikov 2018), monographs on trombiculids of East Palearctics (Kudryashova 1998) and Iran (Stekolnikov *et al.* 2019), revisions of the genera *Microtrombicula* Ewing, 1950 (Vercammen-Grandjean 1965) and *Leptotrombidium* (Vercammen-Grandjean and Langston 1976), and using original descriptions of species. Identifications of three species – *Schoutedenichia zarudnyi* Kudryashova, 1976, *Microtrombicula hoogstraali* (Radford, 1954) and *Microtrombicula traubi* (Muljarskaja and Verdieva, 1974) – were confirmed by the comparison with their type specimens that were examined by the first author during his visits to these museums: Zoological Museum of Moscow State University (ZMMU, Moscow, Russia, in 2017), Natural History Museum (NHM, London, UK, in 2017), and the Natural History Museum of Geneva (MHNG, Geneva, Switzerland, in 2018). Holotypes of all new species will be deposited in the Zoological Institute of the Russian Academy of sciences (ZIN, St. Petersburg, Russia); paratypes will be deposited in ZIN and NHM.

Results

Family Trombiculidae Ewing, 1944
Subfamily Gahrliepiinae Womersley, 1952

Genus *Gahrliepia* Oudemans, 1912

Gahrliepia lawrencei Jadin and Vercammen-Grandjean, 1952

Gahrliepia lawrencei Jadin and Vercammen-Grandjean, 1952: 625, pl. 9; Stekolnikov 2018: 22.
Gahrliepia (Gahrliepia) lawrencei – Traub and Morrow 1955: 67, fig. 187.

Hosts and distribution

Dasymys incomtus (Sundevall) (=*Dasymys bentleyae* Thomas) (Rodentia: Muridae); Africa, Rwanda, Butare (Jadin and Vercammen-Grandjean 1952). *Acomys dimidiatus* (Cretzschmar) (Rodentia: Muridae); Asia, Saudi Arabia, Al Ous' (this study).

Material examined

Two larvae (ZIN 10290 and 10291) from back of *A. dimidiatus*, Saudi Arabia, Al Ous', 26 Aug. 2016.

Genus *Schoengastiella* Hirst, 1915

Schoengastiella wansoni Wolfs and Vercammen-Grandjean, 1953

Schoengastiella wansoni Wolfs and Vercammen-Grandjean, 1953: 207, figs 1–7; Kudryashova 1998: 314; Stekolnikov 2018: 33.

Hosts and distribution

Rattus rattus (L.) (=*Rattus rattus alexandrinus* (É. Geoffroy)) (Rodentia: Muridae) (Wolfs and Vercammen-Grandjean 1953), *Pelomys fallax* (Peters) (Rodentia: Muridae) and *Crocidura* sp. (Soricomorpha: Soricidae) (Stekolnikov 2018); Africa, DR Congo, Bukavu. *Crocidura suaveolens* (Pallas) (Soricomorpha: Soricidae), Asia, Kyrgyzstan, Osh. *Meriones libycus* Lichtenstein (Rodentia: Muridae); Asia, Kyrgyzstan, Aravan (Kudryashova 1998). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' (this study).

Material examined

One larva (ZIN 10289) from anus of *A. dimidiatus*, Saudi Arabia, Al Ous', 25 Aug. 2016.

Genus *Walchia* Ewing, 1931

***Walchia parvula* Schluger, 1955**

Walchia parvula Schluger, 1955: 200, fig. 316; Kudryashova 1998: 317, fig. 277.

Hosts and distribution

Crocidura suaveolens; Asia, Tajikistan, Kondara Gorge (Schluger and Amanguliev 1975). *Calomyscus bailwardi* Thomas (Rodentia: Calomyscidae); Asia, Turkmenistan, Firyuza Gorge (Schluger and Amanguliev 1975). Asia, Azerbaijan (Muljarskaja 1968). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' (this study).

Material examined

One larva (ZIN 10306) from anus of *A. dimidiatus*, Saudi Arabia, Al Ous', 26 Aug. 2016; one larva from chin of *A. dimidiatus*, Saudi Arabia, Al Ous', 26 Aug. 2016.

Subfamily Trombiculinae Ewing, 1929
Tribe Schoengastiini Vercammen-Grandjean, 1960

Genus *Ascoschoengastia* Ewing, 1946

***Ascoschoengastia browni* Taufflieb, Mouchet and Courtois, 1972**

Ascoschoengastia browni Taufflieb, Mouchet and Courtois, 1972: 61, fig. 2; Stekolnikov 2018: 51.

Hosts and distribution

Procavia sp. (Hyracoidea: Procaviidae); Africa, Djibouti, Tadjoura (Taufflieb *et al.* 1972). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' (this study). *Myomyscus yemeni* Sanborn and Hoogstraal (Rodentia: Muridae); Asia, Saudi Arabia, Alogl (this study).

Material examined

Nine larvae (ZIN 10292, 10293, 10295–10298, 10544, 10545, 10547) from back and anus of seven *A. dimidiatus*, Saudi Arabia, Al Ous', 25 Aug. 2016; three larvae (ZIN 10769–10771) from anus of *M. yemeni*, Saudi Arabia, Alogl, 31 Jul. 2017; 13 larvae (ZIN 10824, 10829, 10831, 10834, 10846, 10850, 11150, 11151, 11155, 11156, 14493–14495) from back and ears of seven *A. dimidiatus*, Saudi Arabia, Al Ous', 9–11 Aug. 2017.

Genus *Helenicula* Audy, 1954

***Helenicula lukshumiae* Nadchatram and Traub, 1971**

Helenicula lukshumiae Nadchatram and Traub, 1971: 581, figs. 63–70; Kudryashova *et al.* 1973: 1727; 1978: 162; Kudryashova 1998: 273, fig. 233; Stekolnikov *et al.* 2019: 27.

Helenicula lanius caspica Muljarskaja, 1971: 1188, fig. 4.

Hosts and distribution

Calomyscus sp. (Rodentia: Calomyscidae); Asia, Iran, Kazerun (Nadchatram and Traub 1971). *Meriones persicus* Blanford (Rodentia: Muridae); Asia, Iran: Abhar, Ajami, Behbahan, Chahar Taq, and Mahdishahr (Kudryashova *et al.* 1973, Kudryashova *et al.* 1978, Stekolnikov *et al.* 2019). *Mus musculus* L. (Rodentia: Muridae); Asia, Iran, Ajami (Kudryashova *et al.* 1978, Stekolnikov *et al.* 2019). *Meriones persicus, Meriones tristrami* Thomas, *Microtus arvalis* (Pallas), and *Microtus socialis* (Pallas) (Rodentia: Cricetidae); Asia, Azerbaijan (Muljarskaja 1971, Kudryashova 1998). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' (this study).

Material examined

One larva (ZIN 10310) from back of *A. dimidiatus*, Al Ous', 26 Aug. 2016; nine larvae (ZIN 10812–10820) from back of five *A. dimidiatus*, Al Ous', 10–12 Aug. 2017.

Genus *Schoutedenichia* Jadin and Vercammen-Grandjean, 1954

***Schoutedenichia asirensis* sp. nov.**
(Figs 1, 4, 6–15, Table 1)

Diagnosis

SIF = 4B-N-3-2110.0000; fsp = 7.7.7; fCx = 1.1.2(3); fSt = 2.2; fPp = B(N)/N/NNB; fSc: PL > AM > AL; Ip = 597–647; fD = 2H-(9–11)-8-8(9)-2(3)+(14–21); DS = 45–51; VS = 37–47; NDV = 87–96.

Description (larva) [based on the holotype and 8 paratypes (Nos 10276, 10278, 10281, 10282, 10772, 10775, 10776, 11133); arrangement of idiosomal setae is figured in 7 specimens; coxal formula is recorded in 12 specimens]

Idiosoma (Figs 1, 4, 6–10). Eyes 1 + 1. One pair of humeral setae (C antero-marginal) and 43–49 barbed dorsal idiosomal setae situated on small platelets; 9–11 setae in 1st row (C excluding antero-marginal setae), always 8 setae in 2nd row (D), 8 (9 in one specimen) setae in 3rd row (E); 2 setae in 4th row (F) of 5 specimens and 3 setae in 2 specimens; distribution of caudal setae by rows is uncertain; formula of humeral and dorsal idiosomal setae of holotype fD = 2H-10-8-8-2-9-6-6; four sternal setae; 37–47 ventral setae; total number of idiosomal setae (NDV), excluding scutal, coxal and sternal, 87–96.

Gnathosoma (Figs 11, 12). Cheliceral blade with tricuspid cap; cheliceral base with small puncta in proximal part; gnathobase (infracapitulum) bears one pair of branched tritorostral setae; galeal (deutorostral) setae nude; palpal claw with 3 prongs; palpal femoral seta with few long branches or nude; palpal genual seta nude; dorsal and lateral palpal tibial setae nude, ventral palpal tibial seta branched; palpal tarsus with 4 branched setae and basal tarsala (ω).

Scutum (Fig. 1). Trapezoidal, wider than long, with almost straight anterior and lateral margins and deeply bilobate posterior margin, with small, dense puncta; AM (*vi*) at level of ALs (*ve*); sensillary bases situated far apart (telostigmal scutum) and far anterior to level of PLs (*se*) (PSB – P-PL = 8–13), with curved anteromedial crests; PL > AM > AL; all scutal setae barbed similar to dorsal idiosomal setae; sensilla (*si*) clavate, covered with large pointed scales.

Legs (Figs 13–15). All legs 7-segmented, with 1 pair of claws and claw-like empodium. Leg I: coxa with 1 non-specialized branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae (σ), microgenuala (κ); tibia 8B, 2 tibialae (φ), microtibiala (κ); tarsus 22B, tarsala (ω), microtarsala (ε) at level of tarsala, subterminala (ζ), parasubterminala (z), pretarsala (ζ). Leg II: coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala (σ); tibia 6B, 2 tibialae (φ); tarsus 16B, tarsala (ω), microtarsala (ε) at level of tarsala, pretarsala (ζ). Leg III: coxa 2–3B, sometimes 1B from one side (fCx = 1.1.3 in holotype and one paratype;

1.1.2 in 7 paratypes; 1.1.1/1.1.2 in 2 paratypes; 1.1.2/2.1.3 in 1 paratype); trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala (σ); tibia 6B; tarsus 15B.

Type material

Holotype (ZIN 10774, T-Tr.-87) from anus of *Myomyscus yemeni* (R1, 1-01), Alogl, site 1, 31 Jul. 2017; four paratypes (ZIN 10772, 1773, 10775, 10776) from ear and anus of two *M. yemeni*, Alogl, 31 Jul. 2017 and 2 Aug. 2017; five paratypes (ZIN 10276, 10278, 10281, 10282, 10520) from back and anus of four *Acomys dimidiatus*, Al Ous', 24 and 25 Aug. 2016; two paratypes (ZIN 11132, 11133) from *A. dimidiatus*, Al Ous', 2 Aug. 2017.

Etymology

The new species name refers to the type locality ('Asir Region).

Differential diagnosis

The new species is similar to *Schoutedenichia paulus* Vercammen-Grandjean, 1958 and differs from it by the presence of one pair of eyes vs. two pairs, absence of dorsal teeth of cheliceral blade, larger scutum (AW 48–53 vs. 42, PW 77–86 vs. 56, SD 43–45 vs. 31), longer PL (23–29 vs. 21), fD = 2H-(9–11)-8-8(9)-2(3)+(14–21) vs. 2H-8-6-10-8-10-6-4, and by longer legs (Ip 597–647 vs. 486).

The new species is also similar to *S. morosi* Vercammen-Grandjean, 1958 and differs from it by the presence of one pair of eyes vs. two pairs, nude palpal genual seta vs. branched (fPp = B(N)/N/NNB vs. B/B/NNB, lesser number of idiosomal setae (87–96 vs. 122), larger PW (77–86 vs. 69), SB (36–43 vs. 33), and SD (43–45 vs. 38), and by longer legs (Ip 597–647 vs. 562).

***Schoutedenichia saudi* sp. nov.**
(Figs 2, 3, 5, 16–28, Table 2)

Diagnosis

SIF = 4BS-B-3-2110.0000; fsp = 7.7.7; fCx = 1.1.1; fSt = 2.2; fPp = B/B/NNB; fSc: PL > AM > AL; Ip = 885–1000; fD = 4H-(7–9)-(10–12)+(30–34); DS = 49–57; VS = 66–83; NDV = 116–136.

Description (larva) [based on the holotype and 9 paratypes (Nos 10267, 10270, 10271, 10274, 10525, 10527, 10530, 11126, 11127); arrangement of idiosomal setae is figured in 6 specimens]

Idiosoma (Figs 2, 5, 16–20). Eyes 2 + 2. Two pairs of humeral setae (C antero-marginal) and 45–53 dorsal idiosomal setae covered with strong barbs; 7–9 setae in 1st row (C excluding antero-marginal), 10–12 setae in 2nd row (D), distribution of posterior setae by rows is uncertain; formula of humeral and dorsal idiosomal setae of holotype fD = 4H-9-12-8+22; four sternal setae; 66–83 ventral setae; total number of idiosomal setae (NDV), excluding scutal, coxal and sternal, 116–136.

Gnathosoma (Figs 21, 22). Cheliceral blade with tricuspid cap; gnathobase (infracapitulum) sparsely covered with puncta and bears one pair of branched tritorostral setae; galeal (deutorostral) setae branched; palpal claw with 3 prongs; palpal femoral and genual setae branched; dorsal and lateral palpal tibial setae nude, ventral palpal tibial seta branched; palpal tarsus with 4 branched setae, nude subterminala (ζ), and basal tarsala (ω).

Scutum (Figs 2, 3). Trapezoidal, wider than long, with sinuous anterior margin, almost straight lateral margins, and slightly bilobate posterior margin, with small, dense puncta; AM (*vi*) at level of ALs (*ve*); sensillary bases situated far apart (telostigmal scutum) and far anterior to level of PLs (*se*) (PSB – P-PL = 7–13), with curved anteromedial crests; PL > AM > AL; all scutal setae barbed similar to dorsal idiosomal setae; sensilla (*si*) slightly expanded and densely branched throughout their length.

Legs (Figs 23–28). All legs 7-segmented, with 1 pair of claws and claw-like empodium. Leg I: coxa with 1 non-specialized branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae (σ), microgenuala (κ); tibia 8B, 2 tibialae (φ), microtibiala (κ); tarsus 22B, tarsala (ω), microtarsala (ε) at level of tarsala, subterminala (ζ), parasubterminala (z), pretarsala (ζ). Leg II: coxa 1B; trochanter 1B; basifemur 2B; telofemur 4B; genu 3B, genuala (σ); tibia 6B, 2 tibialae (φ); tarsus 16B, tarsala (ω), microtarsala (ε) at level of tarsala, pretarsala (ζ). Leg III: coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala (σ); tibia 6B; tarsus 15B.

Type material

Holotype (ZIN 11122, T-Tr.-88) from back of *Acomys dimidiatus* (R42, 42-0288), Al Ous', site 2, 12 Aug. 2017; seven paratypes (ZIN 10808, 10809, 11120, 11121, 11128, 11129, 11135) from back of five *A. dimidiatus*, Al Ous', 10–11 Aug. 2017; 39 paratypes (ZIN 10267, 10268, 10270–10275, 10277, 10280, 10283–10288, 10519, 10521–10542) from back and anus of 12 *A. dimidiatus*, Al Ous', 24–26 Aug. 2016; seven paratypes (ZIN 11124–11127, 11130, 11131, 11134) from back of four *A. dimidiatus*, Wosanib, 8 and 13 Aug. 2017.

Etymology

The new species name refers to the ruling dynasty of the Kingdom of Saudi Arabia.

Differential diagnosis

The new species is similar to *Schoutedenichia geckobia* Taufflieb, 1958 and differs from it in the presence of subterminala on palpal tarsus (4BS vs. 4B), presence of two genualae I vs. one genuala I, two pairs of humeral setae vs. one pair, shorter AL (28–33 vs. 43; AM > AL vs. AL > AM), and in longer legs (Ip 885–1000 vs. 757).

Schoutedenichia thracica Kolebinova, 1966

Schoutedenichia (Schoutedenichia) thracica Kolebinova, 1966: 677, figs. 7–12; 1992: 140, fig. 70.

Schoutedenichia thracica – Stekolnikov and Daniel 2012: 91, figs. 64, 65.

Hosts and distribution

Apodemus sylvaticus (L.) (Rodentia: Muridae), *Apodemus mystacinus* (Danford and Alston), *Crocidura suaveolens*; Europe, Bulgaria: Stara Zagora, Sopot, Stara Kresna (Kolebinova 1966, 1992). *Apodemus flavicollis* (Melchior), *A. mystacinus, Apodemus witherbyi* Thomas (Rodentia: Muridae), *Chionomys nivalis* (Martins), *Microtus schidlovskii* Argyropulo (Rodentia: Cricetidae); Asia, Turkey: Bogazkale, Kizlarsivrisi Mt, Karanfil Mt (Stekolnikov and Daniel 2012). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' (this study).

Material examined

One larva (ZIN 10279) from back of *Acomys dimidiatus*, Al Ous', 26 Aug. 2016.

Remarks

This specimen does not conform with the description of *S. thracica* by its branched lateral palpal tibial seta (fPp = B/B/BBB vs. B/B/BNB) and fusiform sensilla (vs. clavate), while all other characters, including measurements, are coincide with those given by Kolebinova (1966, 1992) for the type series and by Stekolnikov and Daniel (2012) for the material from Turkey. Taxonomic significance of these discrepancies is not clear; examination of additional material is required.

One other species, similar to *S. thracica* (and perhaps actually the same species), is *S. infrequens* Abou-Taka, 1985, which was described from Tajikistan (Kudryashova 1998).

***Schoutedenichia zarudnyi* Kudryashova, 1976**
Schoutedenichia zarudnyi Kudryashova, 1976c: 274, fig. 1; Kudryashova *et al.* 1978: 147; Stekolnikov *et al.* 2019: 34.
Schoutedenichia (Schoutedenichia) zarudnyi – Kudryashova 1998: 252, fig. 213.

Hosts and distribution

Tatera indica (Hardwicke) (Rodentia: Muridae) and *Meriones persicus*; Asia, Iran: Borazjan, Kazerun (Kudryashova *et al.* 1978, Stekolnikov *et al.* 2019). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' and Wosanib (this study).

Type material examined

Holotype larva (ZMMU Tdt-670, I-131-2357) from *M. persicus*, Iran, Borazjan, 770 m a.s.l., southern slope of a mountain, 13 November 1969, coll. V.M. Neronov and A. Farang-Azad.

Additional material examined

Four larvae (ZIN 10269, 10311, 10312, 10518) from back and anus of four *A. dimidiatus*, Al Ous', 25 Aug. 2016; one larva (ZIN 11110) from back of *A. dimidiatus*, Al Ous', 11 Aug. 2017; 12 larvae (ZIN 10805–10807, 11111–11119) from back of five *A. dimidiatus*, Wosanib, 8–13 Aug. 2017.

Tribe Trombiculini Vercammen-Grandjean, 1960

Genus *Ericotrombidium* Vercammen-Grandjean, 1966

***Ericotrombidium caucasicum* (Schluger, 1967)**
Leptotrombidium (Ericotrombidium) caucasicum Schluger, 1967: 45, fig. 5; Vercammen-Grandjean and Langston 1976: 762, pl. 231.
Ericotrombidium caucasicum – Kudryashova and Abo-Taka 1986: 98, fig. 2; Kudryashova, 1998: 126, fig. 87; Stekolnikov *et al.* 2014: 592.

Hosts and distribution

Eremias arguta (Pallas) and *Lacerta agilis* L. (Squamata: Lacertidae); Europe, Russia, Stavropol Krai, Bezopasnoye and Ukraine, Odessa Oblast: Zelene, Severny Kantemir, Tarutyne (Schluger 1967, Kudryashova 1998). *Podarcis filfolensis* (Bedriaga) (Squamata: Lacertidae); Europe, Malta, Comino Isl. *Podarcis siculus* (Rafinesque-Schmaltz) (Squamata: Lacertidae); Europe, Italy, Lipari and Alicudi Isls (Stekolnikov *et al.* 2014). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' and Wosanib (this study).

Material examined

Twelve larvae (ZIN 10257, 10323, 10325, 10326, 10330, 10331, 10334, 10337, 10351, 10353, 10355, 10512) from ears, chin, back, anus of nine *A. dimidiatus*, Al Ous', 25 and 26 Aug. 2016; one larva (ZIN 10822) from back of *A. dimidiatus*, Al Ous', 13 Aug. 2017.

***Ericotrombidium galliardi* (Vercammen-Grandjean and Taufflieb, 1959)**
Leptotrombidium galliardi Vercammen-Grandjean and Taufflieb, 1959: 248, pl. 1A, C, E, G, I.
Leptotrombidium (Ericotrombidium) galliardi – Vercammen-Grandjean and Langston 1976: 741, pl. 218.
Ericotrombidium galliardi – Stekolnikov 2018: 131.

Hosts and distribution

Oryctolagus cuniculus (L.) (Lagomorpha: Leporidae) and *Psammodromus algirus* (L.) (Squamata: Lacertidae); Africa, Morocco, Casablanca (Vercammen-Grandjean and Taufflieb 1959). *Myomyscus yemeni* and *Meriones rex* Yerbury and Thomas (Rodentia: Muridae); Asia, Saudi Arabia, Alogl (this study).

Material examined

One larva (ZIN 10759) from anus of *M. yemeni*, Alogl, 4 Aug. 2017; three larvae (ZIN 10765, 11136, 11139) from ears of three *M. rex*, Alogl, 4 and 5 Aug. 2017.

***Ericotrombidium kazeruni* (Kudryashova, 1976)**

Leptotrombidium (Ericotrombidium) kazeruni Kudryashova, 1976a: 39, fig. 5; Kudryashova *et al.* 1978: 119.
Ericotrombidium kazeruni – Kudryashova 2004: 22; Stekolnikov *et al.* 2019: 38.

Hosts and distribution

Tatera indica; Asia, Iran, Kazerun (Kudryashova 1976a). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' and Wosanib (this study). *Meriones rex*; Asia, Saudi Arabia, Alogl (this study).

Material examined

Forty five larvae (ZIN 10258–10266, 10313–10322, 10324, 10327–10329, 10332, 10333, 10335, 10336, 10338–10348, 10350, 10352, 10513–10517) from back, anus, chin of 24 *A. dimidiatus*, Al Ous', 24–26 Aug. 2016; one larva (ZIN 10821) from ear of *A. dimidiatus*, Al Ous', 5 Aug. 2017; one larva (ZIN 11144) from back of *A. dimidiatus*, Al Ous', 12 Aug. 2017; one larva (ZIN 11143) from back of *A. dimidiatus*, Wosanib, 13 Aug. 2017; 20 larvae (ZIN 10751–10758, 10760–10764, 10767, 10768, 11137, 11138, 11140–11142) from ears of eight *M. rex*, Alogl, 5 Aug. 2017.

Genus *Microtrombicula* Ewing, 1950

***Microtrombicula microscuta* sp. nov.**

(Figs 29–46, Table 3)

Diagnosis

SIF = 6BN-N-3-3111.1000; fsp = 7.6.6; fCx = 1.1.1; fSt = 2.2; fPp = B/B/NNB; fSc: PL ≥ AM ≥ AL; Ip = 387–425; fD = 2H-6-6-4-4-4-(0–4); DS = 26–30; VS = 24–26; NDV = 50–54.

Description (larva) [based on the holotype and 7 paratypes (Nos 10309, 10795, 10799, 10800, 10804, 11103, 11104); arrangement of idiosomal setae is figured in 4 specimens]

Idiosoma (Figs 29–36, 40, 41). Eyes 2 + 2. One pair of humeral setae (C antero-marginal) and 24–28 dorsal idiosomal setae covered with long thin barbs and situated on small platelets; 6 setae in 1st row (C excluding antero-marginal), 6 setae in 2nd row (D), by 4 setae in 3–5th rows (E–G); four barbed sternal setae; 24–26 ventral setae; total number of idiosomal setae (NDV), excluding scutal, coxal and sternal, 50–54.

Gnathosoma (Figs 42, 43). Cheliceral blade with tricuspid cap; gnathobase (infracapitulum) bears one pair of branched tritorostral setae; galeal (deutorostral) setae nude; palpal claw with 3 prongs; palpal femoral and genual setae branched; dorsal and lateral palpal tibial setae nude, ventral palpal tibial seta branched; palpal tarsus with 6 setae, 3 nude or bearing one branch and 3 branched, and basal tarsala (ω).

Scutum (Figs 29, 30). Very small, trapezoidal, much longer than width, with unclear anterolateral shoulders, slightly concave lateral margins, and almost straight posterior margin, with large, dense puncta located close to each other (scrobiculate scutum); AM (*vi*) anterior to ALs (*ve*); sensillary bases situated close to each other and far anterior to level of PLs (*se*) (PSB –

P-PL = 14–18); PL ≥ AM ≥ AL; all scutal setae barbed similar to dorsal idiosomal setae; sensilla (*si*) flagelliform, forked.

Legs (Figs 37–39, 44–46). All legs with 1 pair of claws and claw-like empodium. Leg I 7-segmented; legs II and III 6-segmented (basifemur and telofemur fused to form undivided femur). Leg I: coxa with 1 non-specialized branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 3 genualae (σ), microgenuala (κ); tibia 8B, 2 tibialae (φ), microtibiala (κ); tarsus 22B, tarsala (ω), microtarsala (ε) anterior to tarsala, subterminala (ζ), parasubterminala, pretarsala (ζ). Leg II: coxa with 1 non-specialized nude seta (1N); trochanter 1B; femur 6B; genu 3B, genuala (σ); tibia 6B, 2 tibialae (φ); tarsus 16B, tarsala (ω), microtarsala (ε) at level of tarsala, pretarsala (ζ). Leg III: coxa 1B; trochanter 1B; femur 5B; genu 3B, genuala (σ); tibia 6B, tibiala (φ); tarsus 13B, nude mastitarsala.

Type material

Holotype (ZIN 14491, T-Tr.-89) from ear of *Acomys dimidiatus* (R35, 35-0111), Al Ous', site 2, 10 Aug. 2017; 11 paratypes (ZIN 10792–10794, 10796, 10798, 10800–10802, 10804, 11104, 11105) from ears of five *A. dimidiatus*, Al Ous', 10–12 Aug. 2017; one paratype (ZIN 10309) from ear of *A. dimidiatus*, Al Ous', 10 Aug. 2016; seven paratypes (ZIN 10795, 10797, 10799, 11101–11103, 14492) from ears of three *A. dimidiatus*, Wosanib, 8–10 Aug. 2017.

Etymology

The new species name refers to its minute scutum, the size of which is smallest within the genus *Microtrombicula*.

Differential diagnosis

The new species is similar to *Microtrombicula machadoi* Taufflieb, 1965 and differs from it in the presence of a three-pronged palpal claw vs. two-pronged, forked sensilla vs. nude, lower number of idiosomal setae (NDV 50–54 vs. 62), presence of a mastitarsala, smaller scutum (AW 16–19 vs. 27, PW 23–30 vs. 34, SB 6–8 vs. 15, SD 30–33 vs. 37), shorter scutal setae (AM 10–13 vs. 17, AL 9–13 vs. 17, PL 12–16 vs. 21), and shorter legs (Ip 387–425 vs. 443).

***Microtrombicula muhaylensis* sp. nov.**
(Figs 47–59, Table 4)

Diagnosis

SIF = 6BN-N-3-2111.1000; fsp = 7.7.7; fCx = 1.1.1; fSt = 2.2; fPp = B/B/BBB; fSc: PL > AM ≥ AL; Ip = 678–718; fD = 2H-6-6-4-4-2; DS = 22–26; VS = 24–29; NDV = 49–56.

Description (larva) [based on the holotype and 9 paratypes (Nos 10294, 10543, 10546, 10832, 10840–10842, 10848, 14488); arrangement of idiosomal setae is figured in 8 specimens]

Idiosoma (Figs 47–54). Eyes 2 + 2. One pair of humeral setae (C antero-marginal) and 20–24 barbed dorsal idiosomal setae; 6 setae in 1st row (C excluding antero-marginal), 6 setae in 2nd row (D), 4 setae in 3rd row (E), usually 4 setae in 4th row (F) and 2 setae in 5th row (G) (variations: 4-2-3, 4-2-2, and 2-2); four barbed sternal setae; 24–29 ventral setae; total number of idiosomal setae (NDV), excluding scutal, coxal and sternal, 49–56.

Gnathosoma (Figs 55, 56). Cheliceral blade with tricuspid cap; cheliceral base with dense puncta in proximal half; gnathobase (infracapitulum) with sparse puncta, bears one pair of branched tritorostral setae; galeal (deutorostral) setae nude; palpal claw with 3 prongs; palpal femoral, genual, and tibial setae branched; palpal tarsus with 6 setae, 3 nude or bearing one branch and 3 branched, and basal tarsala (ω).

Scutum (Figs 47, 48). Nearly pentagonal, wider than length, with anterolateral shoulders, sinuous anterior margin, slightly concave lateral margins, and rounded posterior margin, with distinct, sparse puncta; AM (*vi*) anterior to ALs (*ve*); sensillary bases anterior to level of PLs (*se*)

(PSB – P-PL = 5–8); PL > AM ≥ AL; all scutal setae barbed similar to dorsal idiosomal setae; sensilla (*si*) flagelliform, with minute scale-like barbs in proximal half and about 10 branches in distal half.

Legs (Figs 57–59). All legs 7-segmented, with 1 pair of claws and claw-like empodium. Leg I: coxa with 1 non-specialized branched seta (1B); trochanter 1B; basifemur 1B; telofemur 5B; genu 4B, 2 genualae (σ), microgenuala (κ); tibia 8B, 2 tibialae (φ), microtibiala (κ); tarsus 22B, tarsala (ω), microtarsala (ε) anterior to tarsala, subterminala (ζ), parasubterminala (z), pretarsala (ζ). Leg II: coxa 1B; trochanter 1B; basifemur 2B; telofemur 4 B; genu 3B, genuala (σ); tibia 6B, 2 tibialae (φ); tarsus 16B, tarsala (ω), microtarsala (ε) at level of tarsala, pretarsala (ζ). Leg III: coxa 1B; trochanter 1B; basifemur 2B; telofemur 3B; genu 3B, genuala (σ); tibia 6B, tibiala (φ); tarsus 13B, nude mastitarsala.

Type material

Holotype (ZIN 10827, T-Tr.-90) from back of *Acomys dimidiatus* (R27, 27-0162), Wosanib, site 1, 9 Aug. 2017; ten paratypes (ZIN 10825, 10830, 10839, 10841, 11123, 11152, 11158, 14488–14490) from back of five *A. dimidiatus*, Wosanib, 8, 9, and 11 Aug. 2017; three paratypes (ZIN 10294, 10543, 10546) from back of three *A. dimidiatus*, Al Ous', 25 Aug. 2016; 20 paratypes (ZIN 10823, 10826, 10828, 10832, 10833, 10835, 10836, 10838, 10840, 10842–10845, 10847–10849, 11153, 11154, 11157, 11159) from back of seven *A. dimidiatus*, Al Ous', 8–13 Aug. 2017; one paratype (ZIN 11106) from ear of *Meriones rex*, Alogl, 5 Aug. 2017.

Etymology

The new species name refers to Muhayl, a traditional name of the territory within 'Asir Region where the type locality is situated.

Differential diagnosis

The new species is similar to *Microtrombicula meriones* (Vercammen-Grandjean, Rohde and Mesghali, 1970) and differs from it in the presence of two pairs of eyes vs. one pair, lower number of idiosomal setae (NDV 49–56 vs. 68, fD = 2H-6-6-4-4-2 vs. 2H-6-6-4-4-4-4-2), PL > AM ≥ AL vs. AM ≥ PL > AL, and in smaller scutum (AW 42–47 vs. 57, PW 56–65 vs. 71, PSB 18–20 vs. 27, SD 39–44 vs. 55).

***Microtrombicula centropi* (Vercammen-Grandjean, 1965)**

Eltonella (Eltonella) centropi centropi Vercammen-Grandjean, 1965: 73, pls R–S.
Microtrombicula centropi – Stekolnikov 2018: 148.

Hosts and distribution

Centropus grillii Hartlaub (Cuculiformes: Cuculidae); Africa, DR Congo, Bukavu (Vercammen-Grandjean 1965). *Acomys dimidiatus*; Asia, Saudi Arabia, Wosanib (this study).

Material examined

One larva (ZIN 10837) from back of *A. dimidiatus*, Wosanib, 9 Aug. 2017.

***Microtrombicula hoogstraali* (Radford, 1954)**

Trombicula hoogstraali Radford, 1954: 297, fig. 48.
Microtrombicula (Microtrombicula) hoogstraali – Vercammen-Grandjean 1965: 89, pls LL (4–8), AD.

Hosts and distribution

Rattus rattus; Asia, Yemen, Taiz (Radford 1954). *Myomyscus yemeni* and *Meriones rex*; Asia, Saudi Arabia, Alogl (this study).

Type material examined

Paratype larva (NHM 1952.7.23.10) from *Rattus rattus*, Yemen, Ta'izz (Taiz), 1951, K.L. Knight; paratype larva (MHNG) with same data.

Additional material examined

Eight larvae (ZIN 10766, 10782, 10784, 10787, 10789–10791, 11109) from ears of three *M. yemeni*, Alogl, 31 Jul. 2017, 4 and 5 Aug. 2017; 11 larvae (ZIN 10777–10781, 10783, 10785, 10786, 10788, 11107, 11108) from ears of seven *M. rex*, Alogl, 5 Jul. 2017 and 13 Aug. 2017.

***Microtrombicula hyracis* (Vercammen-Grandjean, 1965)**

Eltonella (Eltonella) hyracis Vercammen-Grandjean, 1965: 67, pl. J.
Microtrombicula hyracis – Stekolnikov 2018: 153.

Hosts and distribution

Procaviidae gen. sp.; Africa, Uganda, Kaabong (Vercammen-Grandjean 1965) and Djibouti, Tadjoura (Taufflieb *et al.* 1972). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' (this study).

Material examined

One larva (ZIN 10300) from anus of *A. dimidiatus*, Al Ous', 25 Aug. 2016; one larva (ZIN 10301) from chin of *A. dimidiatus*, Al Ous', 26 Aug. 2016.

***Microtrombicula traubi* (Muljarskaja and Verdieva, 1974)**

Microtrombidium traubi Muljarskaja and Verdieva, 1974: 77, figs. 1–4.
Microtrombicula traubi – Kudryashova 1998: 88, fig. 50; Stekolnikov *et al.* 2019: 46.
Eltonella grossa Kudryashova, 1976b: 301, figs 2, 3; Kudryashova *et al.* 1978: 109, fig. 8.

Hosts and distribution

Meriones persicus; Asia, Azerbaijan (Muljarskaja and Verdieva 1974, Kudryashova 1998) and Iran, Ajami (Kudryashova 1976b, 1998). *Meriones crassus* Sundevall; Asia, Iran, Hajiabad (Kudryashova 1976b, 1998). *Allactaga williamsi* Thomas (Rodentia: Dipodidae) and *Mus musculus*; Asia, Azerbaijan (Kudryashova 1998). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' and Wosanib (this study).

Type material examined

Holotype larva of *Eltonella grossa* (ZMMU Tdt-349, I-367-1122-26) from *Meriones crassus*, Iran, Hajiabad, 1,900 m a.s.l., 20 August 1969, coll. V.M. Neronov.

Additional material examined

Two larvae (ZIN 10299 and 10308) from ears of two *A. dimidiatus*, Al Ous', 1 and 26 Aug. 2016; three larvae (ZIN 10803, 11099, 11100) from ears of three *A. dimidiatus*, Wosanib, 13 Aug. 2017.

Genus *Pentidionis* Vercammen-Grandjean and Loomis, 1967

***Pentidionis agamae* (André, 1929)**

Thrombicula agamae André, 1929: 402, figs 1–2.
Hexidionis (Pentidionis) agamae – Vercammen-Grandjean and Loomis 1967: 140; Vercammen-Grandjean *et al.* 1970: 774, fig. 2.
Pentidionis agamae – Lucas and Loomis 1968: 233; Stekolnikov *et al.* 2019: 56.

Hosts and distribution

Stellagama stellio (L.) (Squamata: Agamidae); Asia, Israel-Palestine, Tiberias (André 1929). *Agama* sp. (Squamata: Agamidae); Asia, Iran, Kazerun (Vercammen-Grandjean *et al.* 1970). *Acomys dimidiatus*; Asia, Saudi Arabia, Al Ous' and Wosanib (this study).

Material examined

Fourteen larvae (ZIN 10302–10305, 10305/2, 10548–10556) from ears, chin, back, anus of nine *A. dimidiatus*, Al Ous', 24 Aug. 2016; six larvae (ZIN 10810, 10811, 11145, 11146, 11148, 11149) from ear and back of five *A. dimidiatus*, Al Ous', 10–12 Aug. 2017; one larva (ZIN 11147) from back of *A. dimidiatus*, Wosanib, 13 Aug. 2017.

Discussion

Unlike the other parts of Saudi Arabia, 'Asir is mainly a mountainous region, with the highest peak (Jabal Sawda) reaching ~3,000 m a.s.l.. Annual rainfall at the sites where we trapped rodents has been reported as >200 mm, while the peak can receive 500 mm (Abulfatih, 1992). Moreover, summer average maximum temperatures remain <35°C, while humidity in the winter months can reach almost 100%, leading to heavy fog. Thus, the fact that the trombiculid fauna of 'Asir was comparable by the number of species to that of Central Africa, Southern Turkey, and Northern Iran is perhaps not as surprising as it first appears. Furthermore, 'Asir is situated at the border between the Ethiopian and Palearctic zoogeographical regions; therefore, a mixture of African and Asian species is not wholly unexpected.

Chigger mites are poorly investigated in the African countries proximal to the Arabian Peninsula. Thus, only two localities were sampled in Egypt with two new species described; the same is true for Somalia and Ethiopia; one species was described from the type locality in Eritrea; and one locality was sampled in Djibouti, with four species recorded (Stekolnikov 2018). A few data on chiggers were obtained in Israel-Palestine (André 1929, Radford 1957). Nothing is known on the chigger fauna of Jordan, Syria, and Iraq, but trombiculids of Iran were investigated in some detail: 48 sites were sampled, with 85 chigger species being recorded (Stekolnikov *et al.* 2019). The chigger fauna of Turkey includes 43 species (Stekolnikov and Daniel 2012); trombiculids of Transcaucasia (Georgia, Armenia, and Azerbaijan) were reviewed in the monograph on the chigger fauna of the former USSR (Kudryashova 1998).

Only one species in our collection, *M. hoogstraali*, was described in Yemen, which borders the 'Asir Region. Five species, *H. lukshumiae, S. zarudnyi, E. kazeruni, M. traubi,* and *P. agamae*, are elements of the Iranian fauna (*H. lukshumiae* and *M. traubi* were also recorded in bordering Azerbaijan, and *P. agamae* was described from Israel-Palestine). One more connection with the Iranian chiggers is *M. muhaylensis* **sp. nov.**, which is similar to *M. meriones* described in Iran.

The next group of species represents a connection of Saudi Arabian chiggers with the fauna of Sub-Saharan Africa. Two species, *G. lawrencei* and *M. centropi*, were known only from Central Africa. In addition, *S. asirensis* **sp. nov.** is similar to a Central African species, *S. paulus*; and *M. microscuta* is similar to *M. machadoi* described from Angola. One species, *M. hyracis*, was recorded both in Central and Eastern Africa (Uganda and Djibouti), and *A. browni* was previously known only from its type locality in Djibouti; *i.e.*, ~650 km south of the 'Asir Region across the Red Sea. *S. wansoni*, which was described from DR Congo, later was recorded in Kyrgyzstan, suggesting that it has a wide range extending from Central Africa to Central Asia.

E. galliardi, known from Morocco, is a representative of the Mediterranean chigger fauna, whereas the range of two other species, *E. caucasicum* and *S. thracica*, extends from the Mediterranean Basin to the nearby territories of Eastern Europe. *S. saudi* **sp. nov.** is also closely related to *S. geckobia* described from Morocco. In addition, the last species found in Saudi Arabia, *W. parvula*, was previously recorded only in Central Asia and Azerbaijan.

Therefore, our data reveal that many chigger species could have wide ranges extending from Central Africa to Western and even Central Asia, and from south of the Arabian Peninsula

to Eastern Europe. Six species were for the first time recorded outside their type localities (*G. lawrencei* from Rwanda, *A. browni* from Djibouti, *E. galliardi* from Morocco, *E. kazeruni* from Iran, *M. centropi* from DR Congo, and *M. hoogstraali* from Yemen). Previously, only eight African species have been recorded outside the continent (Stekolnikov 2018); our collection adds five more such species (*G. lawrencei, A. browni, E. galliardi, M. centropi,* and *M. hyracis*).

As the chigger-transmitted pathogen *Orientia chuto* has been reported from the United Arab Emirates and Kenya (Izzard *et al.* 2010, Masakhwe *et al.* 2018), the latter in *Microtrombicula* spp. chiggers, our findings may also contribute in time to understanding the distribution of scrub typhus outside its Asia-Pacific heartland.

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TABLE 1. *Schoutedenichia asirensis* **sp. nov.,** measurements (n = 9).

	Holotype	Range	Mean
AW	52	48–53	51
PW	80	77–86	80
SB	43	36–43	41
ASB	23	20–24	23
PSB	22	20–23	21
SD	45	43–45	44
P-PL	11	9–14	11
AP	34	32–35	33
AM	23	21–23	22
AL	18	16–21	18
PL	29	23–29	27
S	31	25–32	30
H	25	23–26	25
D_{min}	18	14–18	16
D_{max}	23	20–23	22
V_{min}	16	14–18	15
V_{max}	21	18–23	20
pa	221	211–230	220
pm	193	178–196	189
pp	214	203–223	214
Ip	628	597–647	623
DS	51	45–51	49
VS	37	37–47	42
NDV	88	87–96	91
TaIIIL	55	52–61	56
TaIIIW	12	12–14	13
S_1	12	10–12	11
S_2	16	15–16	16

Abbreviations: AW—distance between anterolateral scutal setae; PW—distance between posterolateral scutal setae; SB—distance between sensillary bases; ASB—distance from the level of sensillary bases to extreme anterior margin of scutum; PSB—distance from the level of sensillary bases to extreme posterior margin of scutum; SD—length of scutum (ASB + PSB); P-PL—distance from the level of posterolateral scutal setae to extreme posterior margin of scutum; AP—distance between antero- and posterolateral scutal seta on one side; AM—length of anteromedian scutal seta; AL—length of anterolateral scutal setae; PL—length of posterolateral scutal setae; S—length of sensilla; H—length of humeral setae; D_{min}—length of the shortest dorsal idiosomal seta; D_{max}—length of the longest dorsal idiosomal seta; V_{min}—length of the shortest ventral idiosomal seta; V_{max}—length of the longest ventral idiosomal seta; pa—length of leg I (excluding claws and including coxa); pm—length of leg II (excluding claws and including coxa); pp—length of leg III (excluding claws and including coxa); Ip—sum of leg lengths (pa + pm + pp); DS—number of dorsal idiosomal setae (excluding scutal and including humeral); VS—number of ventral idiosomal setae (excluding coxal and sternal); NDV—number of idiosomal setae (DS + VS); TaIIIL—length of leg tarsus III; TaIIIW—width of leg tarsus III; S_1—length of tarsala I (ω); S_2—length of tarsala II (ω).

TABLE 2. *Schoutedenichia saudi* **sp. nov.,** measurements (n = 10).

	Holotype	Range	Mean
AW	57	52–65	60
PW	89	82–101	94
SB	48	47–54	51
ASB	31	29–32	31
PSB	18	16–20	17
SD	49	45–52	49
P-PL	5	5–9	7
AP	41	37–44	41
AM	37	34–40	37
AL	31	28–33	30
PL	50	45–55	50
S	66	59–66	62
H	45	44–51	47
D_{min}	32	29–34	32
D_{max}	44	44–56	49
V_{min}	24	20–25	23
V_{max}	38	36–43	40
pa	320	315–353	335
pm	275	266–301	285
pp	319	304–346	328
Ip	914	885–1000	948
DS	55	49–57	54
VS	66	66–83	74
NDV	121	116–136	127
TaIIIL	87	81–94	88
TaIIIW	15	14–16	15
S_1	-	20–20	20
S_2	-	25–25	25

Abbreviations: as in Table 1.

TABLE 3. *Microtrombicula microscuta* **sp. nov.,** measurements (n = 8).

	Holotype	Range	Mean
AW	16	16–19	17
PW	25	23–30	26
SB	6	6–8	7
ASB	14	14–17	15
PSB	16	14–18	16
SD	30	30–33	31
P-PL	2	2–2	2
AP	22	22–24	23
AM	12	10–13	12
AL	10	9–13	10
PL	16	12–16	14
S	16	16–26	21
H	23	18–23	21
D_{min}	13	13–15	14
D_{max}	18	17–20	18
V_{min}	13	10–13	12
V_{max}	14	13–16	15
pa	155	142–155	151
pm	122	117–126	121
pp	137	128–144	137
Ip	414	387–425	409
DS	-	26–30	28
VS	-	24–26	25
NDV	-	50–54	53
TaIIIL	35	34–37	35
TaIIIW	11	10–13	12
dmt	11	11–13	12
S_1	-	11–11	11
S_2	-	13–13	13

dmt—distance from the base of tarsus III to the base of mastitarsala. Other abbreviations: as in Table 1.

TABLE 4. *Microtrombicula muhaylensis* **sp. nov.,** measurements (n = 10).

	Holotype	Range	Mean
AW	47	42–47	46
PW	59	56–65	59
SB	21	20–23	21
ASB	23	21–25	23
PSB	20	18–20	19
SD	43	39–44	42
P-PL	13	11–14	13
AP	24	23–25	24
AM	36	25–36	31
AL	30	23–30	27
PL	39	34–40	37
S	54	54–54	54
H	43	38–47	42
D_{min}	32	23–33	30
D_{max}	39	34–41	37
V_{min}	23	20–25	22
V_{max}	35	27–35	30
pa	257	241–257	249
pm	214	202–214	208
pp	247	232–247	239
Ip	718	678–718	696
DS	-	22–26	24
VS	-	24–29	29
NDV	-	49–56	53
TaIIIL	68	63–71	68
TaIIIW	12	11–13	12
dmt	16	14–21	18
S_1	-	12–14	13
S_2	-	18–21	20

dmt—distance from the base of tarsus III to the base of mastitarsala. Other abbreviations: as in Table 1.

Legends to figures

FIGURES 1–5. *Schoutedenichia asirensis* **sp. nov.,** larva holotype (1, 4) and *S. saudi* **sp. nov.,** larva holotype (2, 3, 5): 1, 2—scutum, eyes, and dorsal idiosomal setae. Scale bar 50 μm; 3—scutum and eyes. Scale bar 50 μm; 4, 5—sternal area of idiosoma. Scale bar 50 μm. AL—anterolateral scutal seta (*ve*); AM—anteromedial scutal seta (*vi*); cxI—coxa I; cxII—coxa II; cxIII—coxa III; D_1—dorsal idiosomal setae of 1st row (C); gns—gnathocoxal seta; H—humeral seta (C antero-marginal); ic—infracapitulum (gnathobase); PL—posterolateral scutal seta (*se*); S—sensillum (*si*); SB—sensillary base; sta—anterior sternal seta; stp—posterior sternal seta; V—preanal ventral idiosomal setae.

FIGURES 6–12. *Schoutedenichia asirensis* **sp. nov.,** larva: 6—arrangement of dorsal idiosomal setae in paratype 10776; 7—arrangement of ventral idiosomal setae in paratype 10776; 8—humeral seta (C antero-marginal) in holotype; 9—dorsal idiosomal seta of 1st row (C) in holotype; 10—preanal ventral idiosomal seta in holotype; 11—dorsal aspect of gnathosoma in holotype; 12—ventral aspect of gnathosoma in holotype. Scale bar 100 μm (6, 7), 20 μm (8–12). Ch—cheliceral blade; Ga—galeal (deutorostral) seta; gns—gnathocoxal seta; PC—palpal claw; PF—palpal femur; PG—palpal genu; PTa—palpal tarsus; PTi—palpal tibia; S_0—palpal tarsala (ω).

FIGURES 13–15. *Schoutedenichia asirensis* **sp. nov.,** larva holotype: 13—free part of leg I (trochanter–tarsus); 14—free part of leg II (trochanter–tarsus); 15—free part of leg III (trochanter–tarsus). Scale bar 50 μm. f_1—famulus I (ε); f_2—famulus II (ε); ga—genuala I (σ); gm—genuala II (σ); gp—genuala III (σ); μga—microgenuala (κ); μta—microtibiala (κ); pST—parasubterminala (z); PT'—pretarsala I (ζ); PT''—pretarsala II (ζ); S_1—tarsala I (ω); S_2—tarsala II (ω); ST—leg subterminala (ζ); ta—tibiala I (φ); tm—tibiala II (φ).

FIGURES 16–22. *Schoutedenichia saudi* **sp. nov.,** larva: 16— arrangement of dorsal idiosomal setae in paratype 10267; 17— arrangement of ventral idiosomal setae in paratype 10267; 18—humeral seta in holotype (C antero-marginal); 19—dorsal idiosomal seta of 1st row (C) in holotype; 20—ventral preanal idiosomal seta in holotype; 21—dorsal aspect of gnathosoma in holotype; 22—ventral aspect of gnathosoma in holotype. Scale bar 200 μm (16, 17), 20 μm (18–22). PST—palpal subterminala (ζ). Other abbreviations as in Figs 6–12.

FIGURES 23–28. *Schoutedenichia saudi* **sp. nov.,** larva holotype: 23—genu, tibia, and tarsus of leg I; 24—trochanter, basifemur, and telofemur of leg I; 25— trochanter, basifemur, and telofemur of leg II; 26—genu, tibia, and tarsus of leg II; 27—genu, tibia, and tarsus of leg III; 28— trochanter, basifemur, and telofemur of leg III. Scale bar 50 μm. Abbreviations as in Figs 10–12.

FIGURES 29–31. *Microtrombicula microscuta* **sp. nov.,** larva holotype: 29—scutum, eyes, and dorsal idiosomal setae. Scale bar 50 μm; 30—scutum and eyes. Scale bar 20 μm; 31—sternal area of idiosoma. Scale bar 50 μm. Abbreviations as in Figs 1–5.

FIGURES 32–43. *Microtrombicula microscuta* **sp. nov.,** larva: 32—arrangement of dorsal idiosomal setae in paratype 10804; 33—arrangement of ventral idiosomal setae in paratype 10804; 34—humeral seta (C antero-marginal) in paratype 10309; 35—dorsal idiosomal seta of 1st row (C) in paratype 10309; 36—preanal ventral idiosomal seta in paratype 10309; 37—coxal seta I in paratype 10309; 38—coxal seta II in paratype 10309; 39—coxal seta III in paratype 10309; 40—anterior sternal seta in paratype 10309; 41—posterior sternal seta in paratype 10309; 42—ventral aspect of gnathosoma in paratype 10309; 43—dorsal aspect of gnathosoma in paratype 10309. Scale bar 100 μm (32, 33), 20 μm (34–43). Abbreviations as in Figs 6–12.

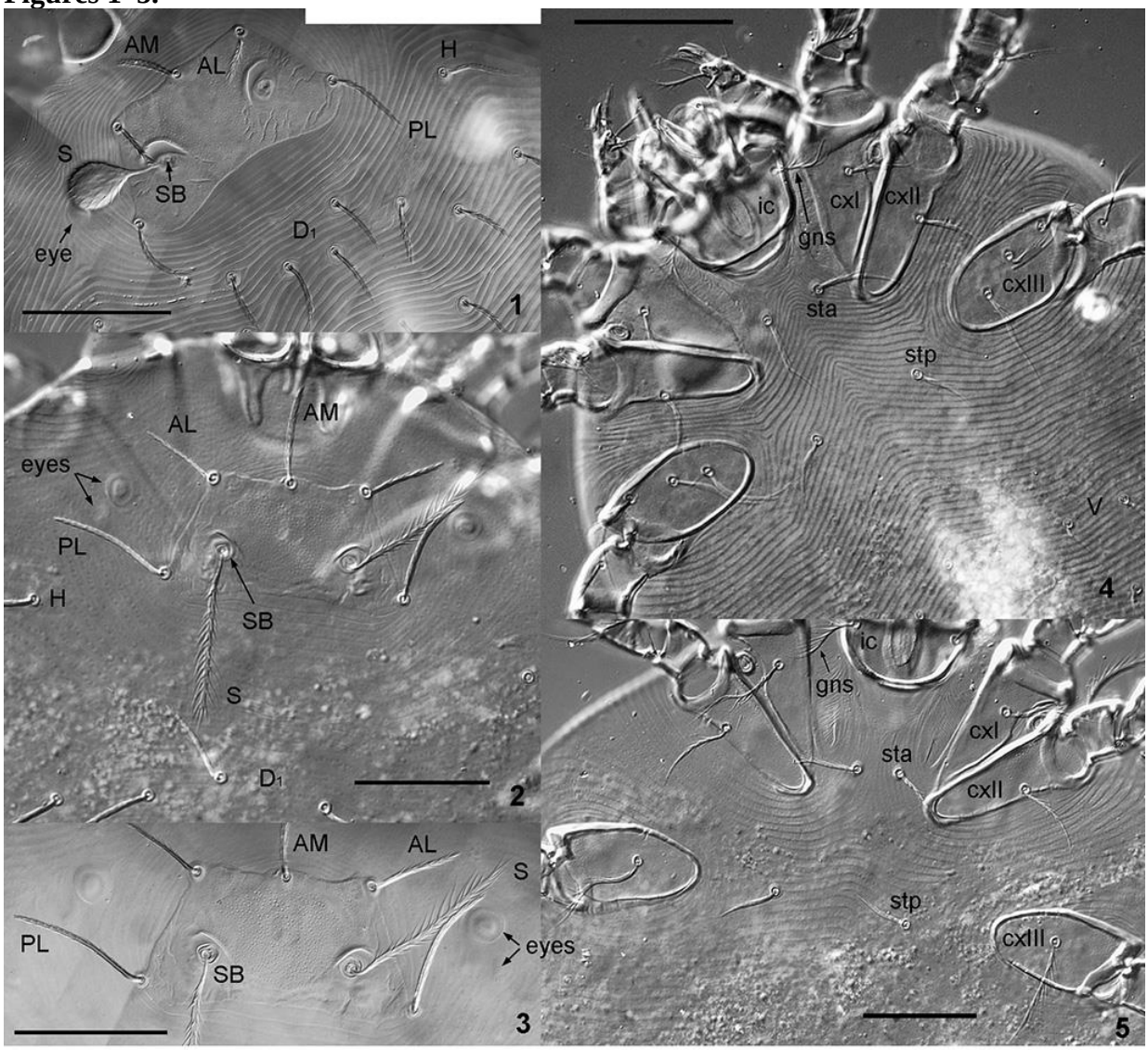
FIGURES 44–46. *Microtrombicula microscuta* **sp. nov.,** larva paratype 10804: 44—free part of leg I (trochanter–tarsus); 45—free part of leg II (trochanter–tarsus); 46—free part of leg III (trochanter–tarsus). Scale bar 20 μm. MTa—mastitarsala. Other abbreviations as in Figs 13–15.

FIGURES 47–49. *Microtrombicula muhaylensis* **sp. nov.,** larva holotype: 47—scutum, eyes, and dorsal idiosomal setae. Scale bar 50 μm; 48—scutum, eyes, and dorsal idiosomal setae. Scale bar 50 μm; 49—sternal area of idiosoma. Scale bar 50 μm. Abbreviations as in Figs 1–5.

FIGURES 50–56. *Microtrombicula muhaylensis* **sp. nov.,** larva: 50—arrangement of dorsal idiosomal setae in paratype 10841; 51—arrangement of ventral idiosomal setae in paratype 10841; 52—humeral seta (C antero-marginal) in paratype 10840; 53—dorsal idiosomal seta of 1st row (C) in paratype 10840; 54—preanal ventral idiosomal seta in paratype 10840; 55—dorsal aspect of gnathosoma in paratype 10840; 56—ventral aspect of gnathosoma in paratype 10840. Scale bar 100 μm (50, 51), 20 μm (52–56). Abbreviations as in Figs 6–12.

FIGURES 57–59. *Microtrombicula muhaylensis* **sp. nov.,** larva paratype 10840: 57—free part of leg I (trochanter–tarsus); 58—free part of leg II (trochanter–tarsus); 59—free part of leg III (trochanter–tarsus). Scale bar 50 μm. MTa—mastitarsala. Other abbreviations as in Figs 13–15.

Figures 1–5.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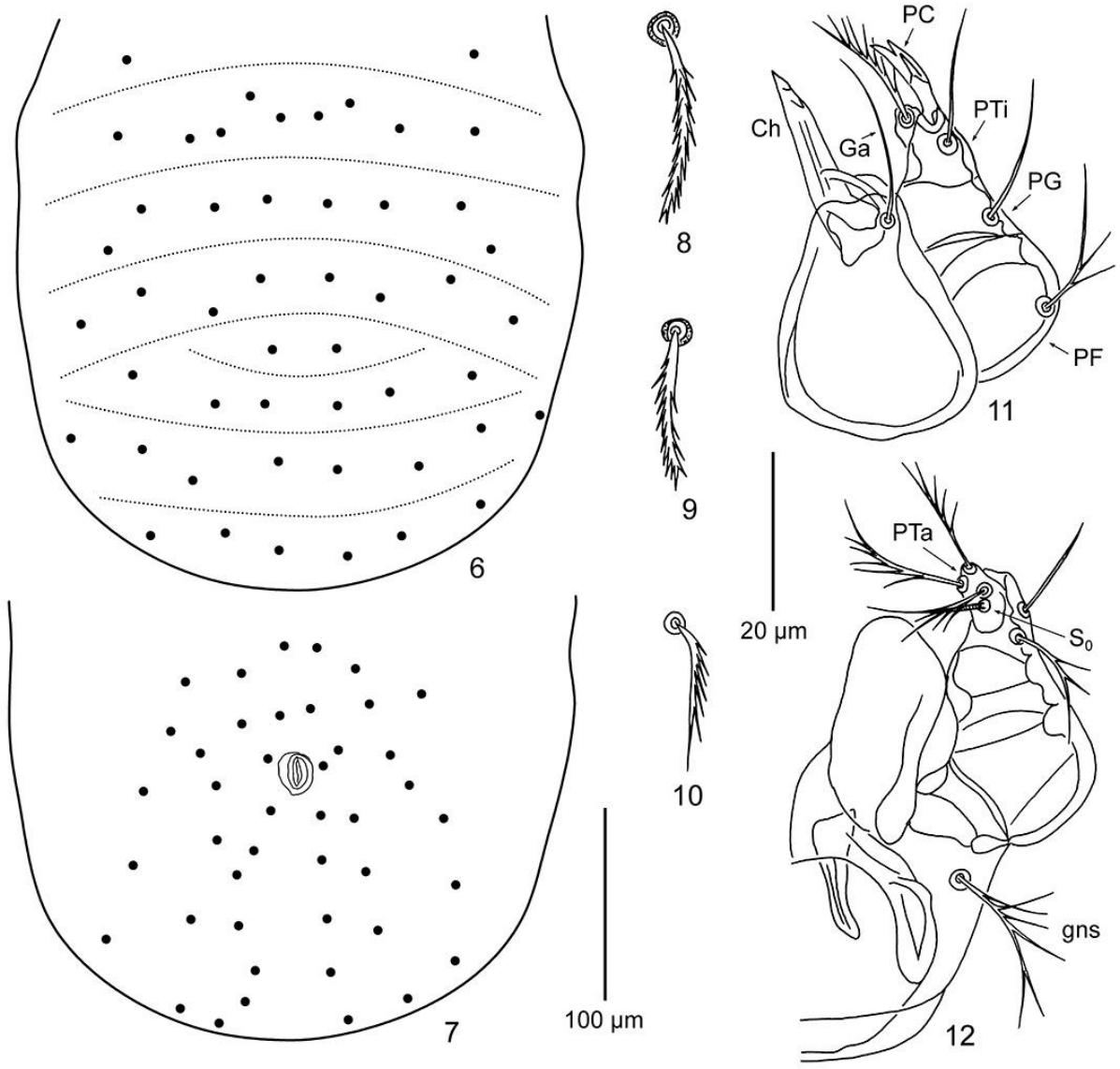
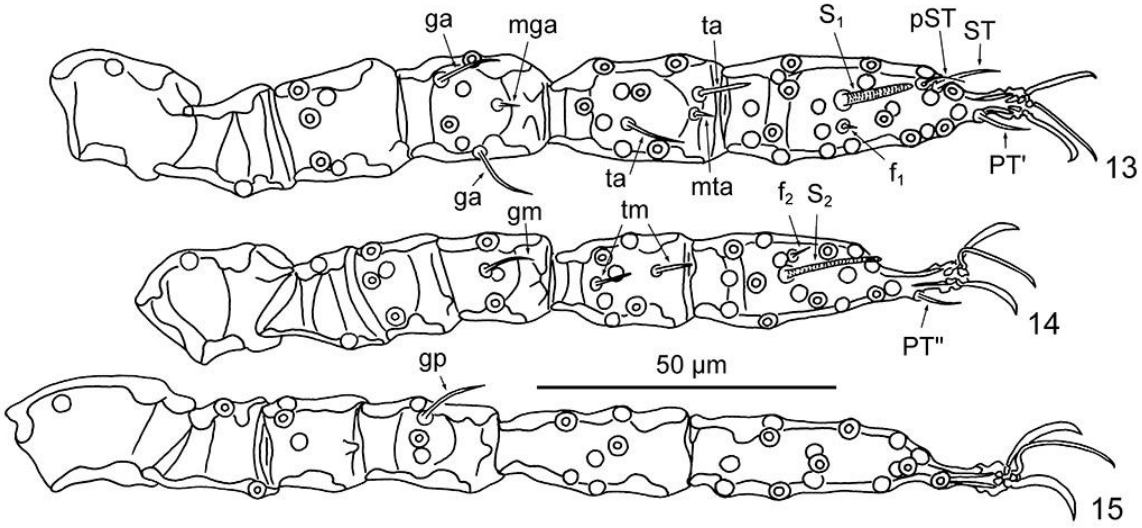
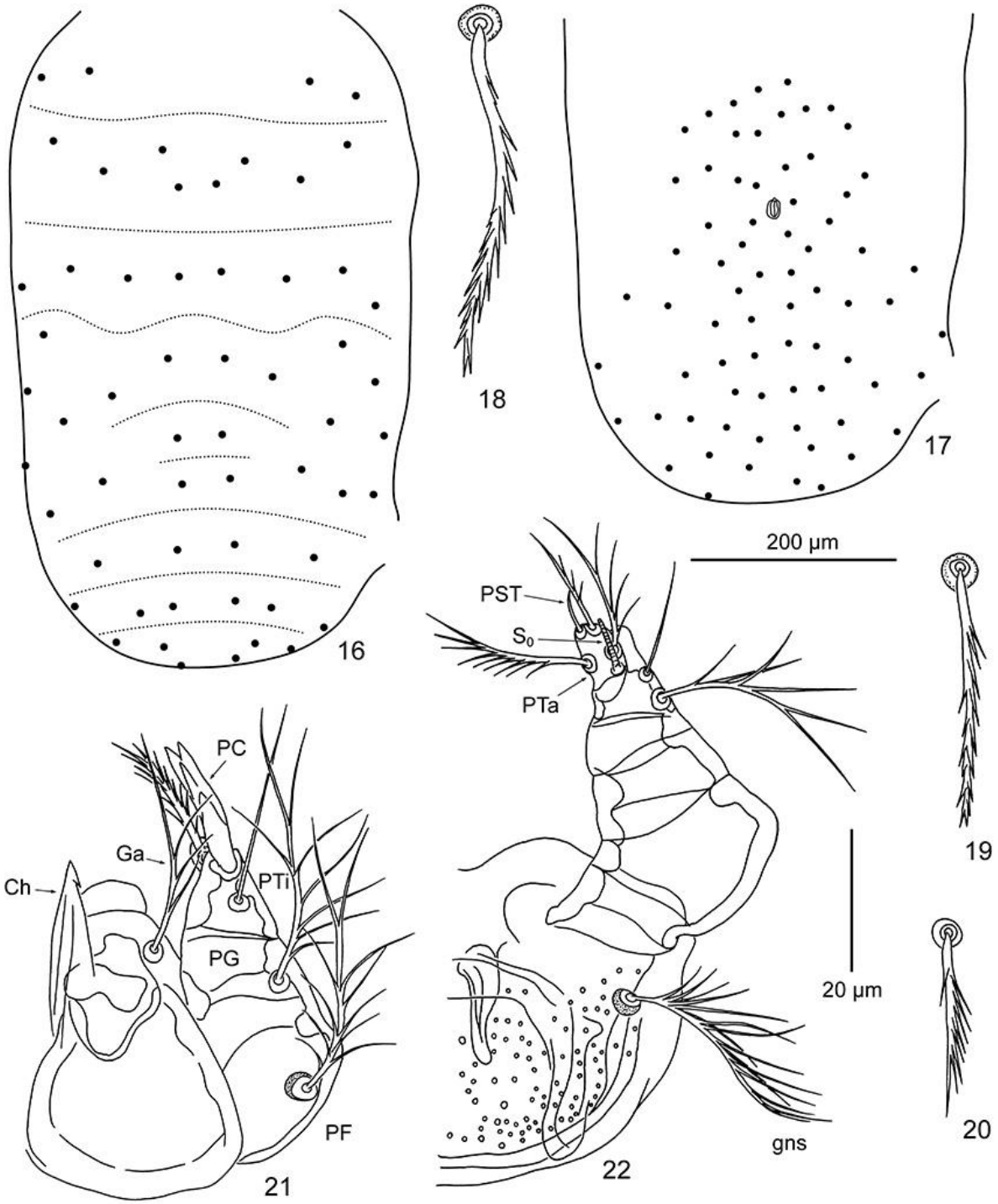
Figures 6–12.



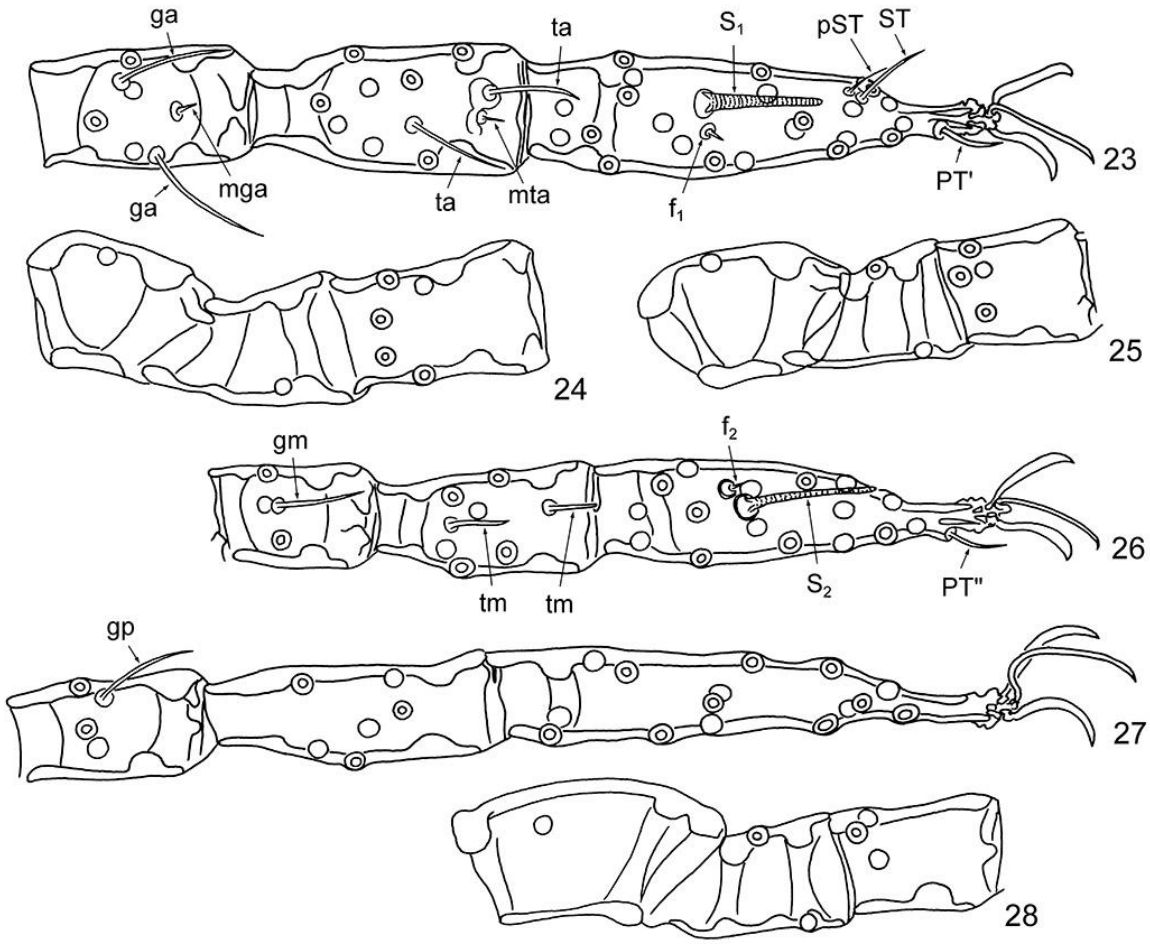
Figures 13–15.



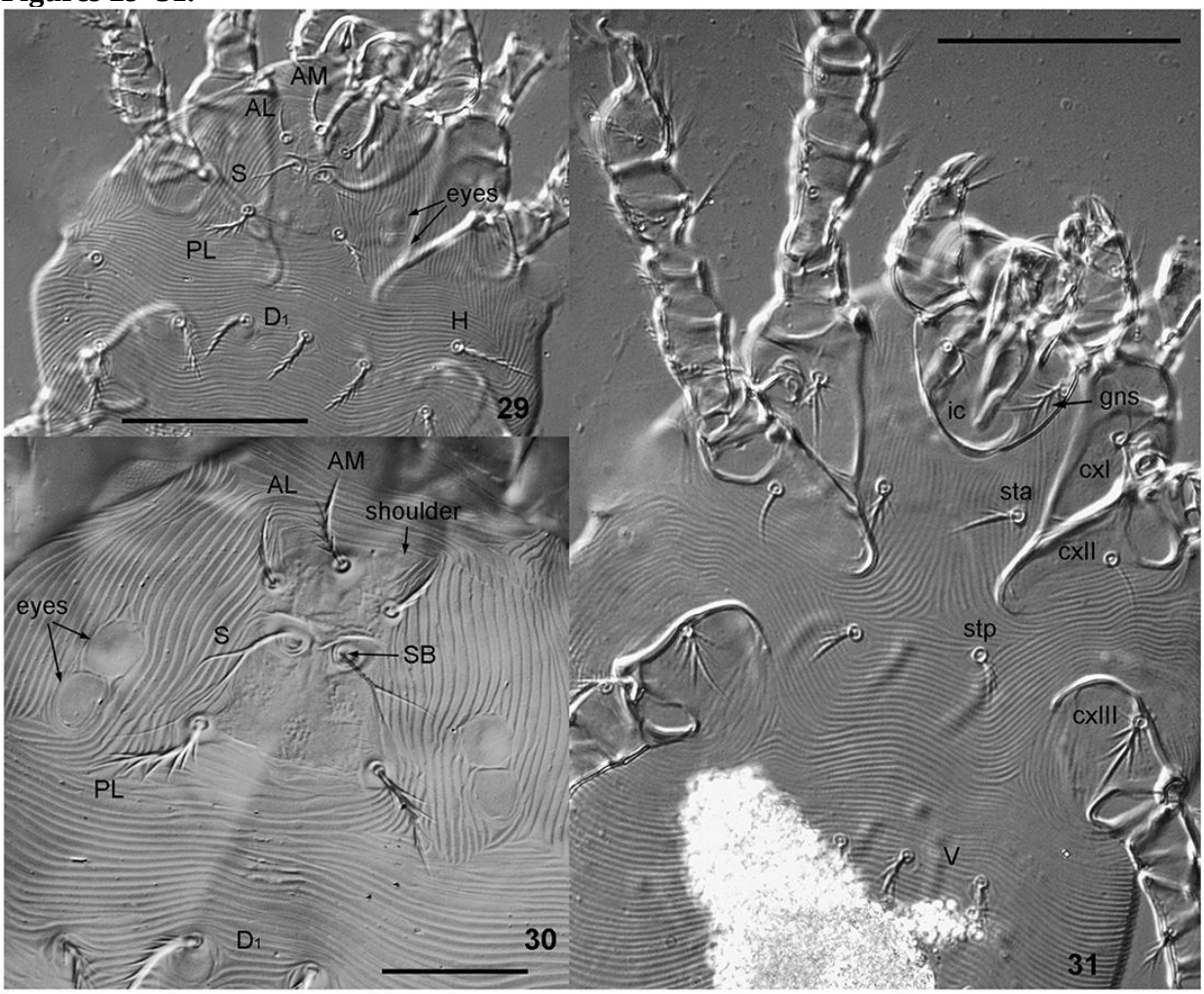
Figures 16–22.



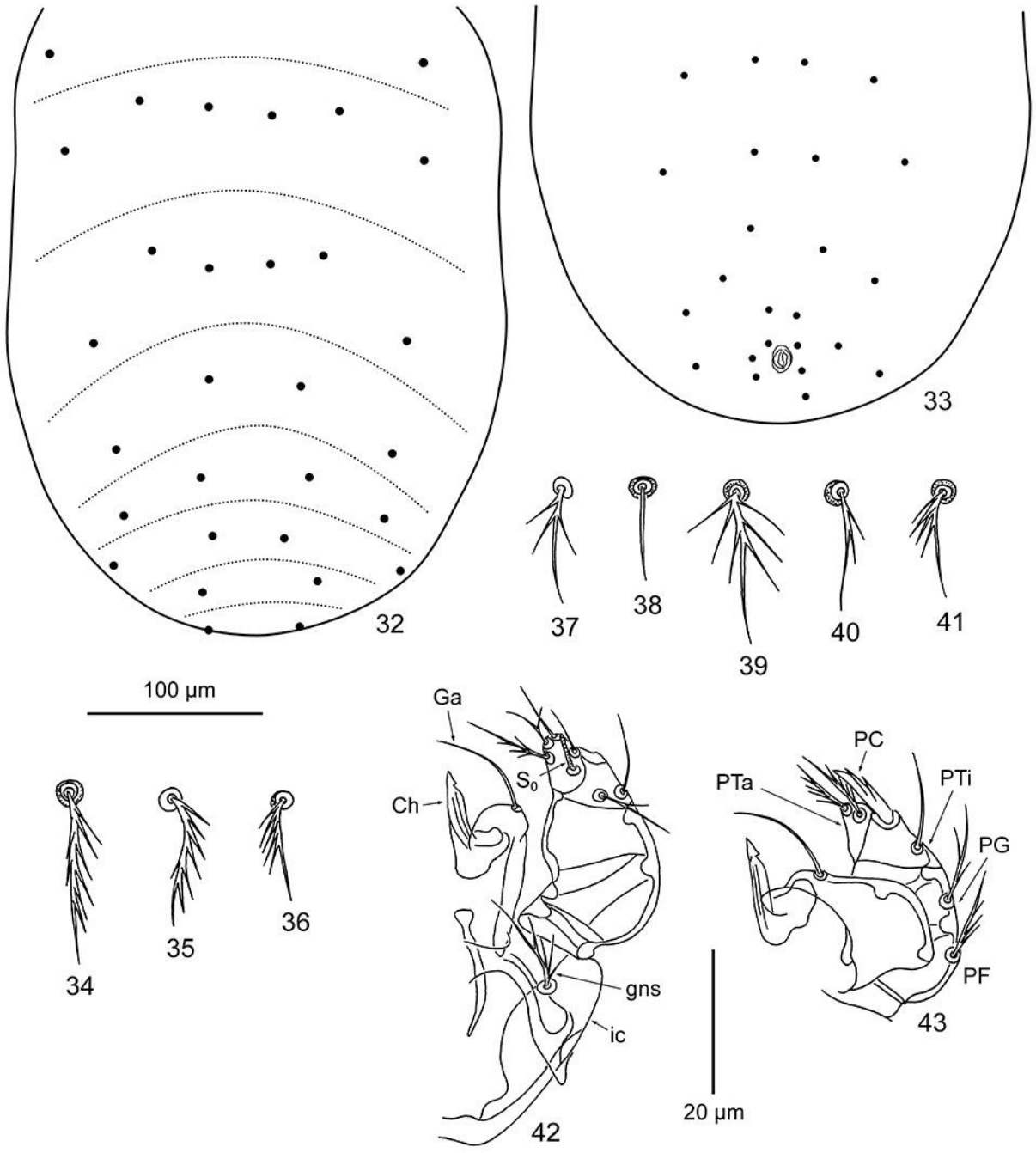
Figures 23–28.



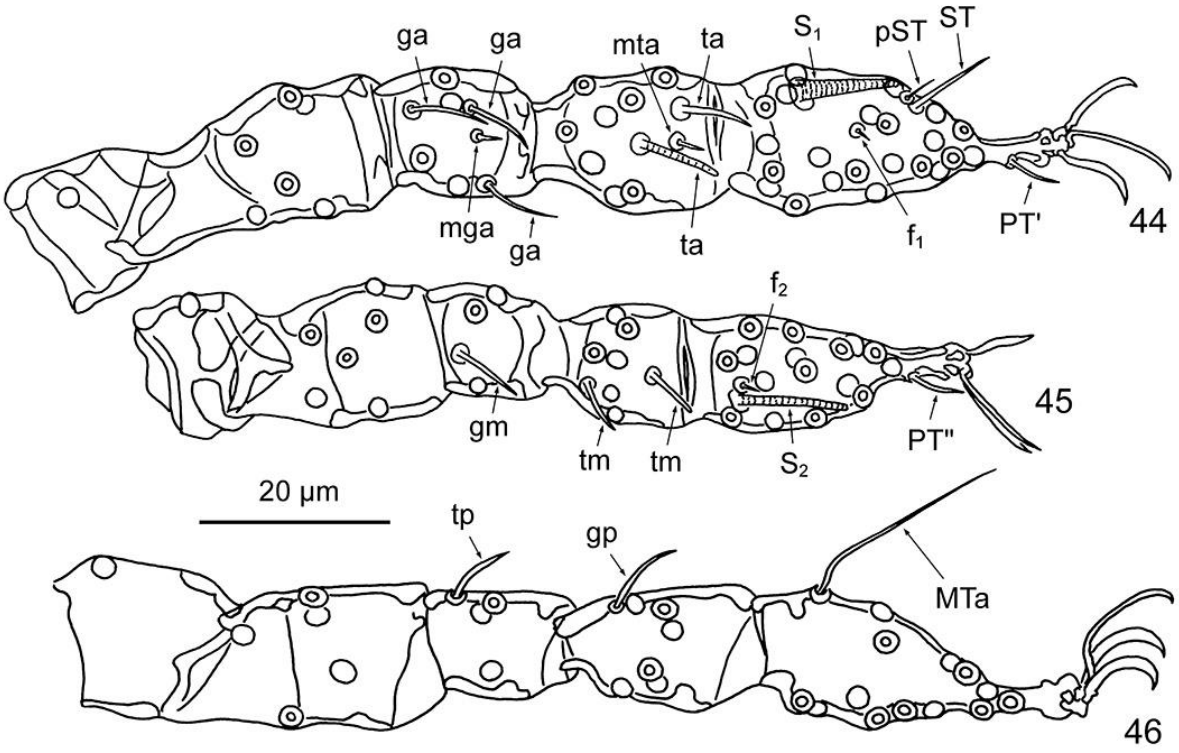
Figures 29–31.



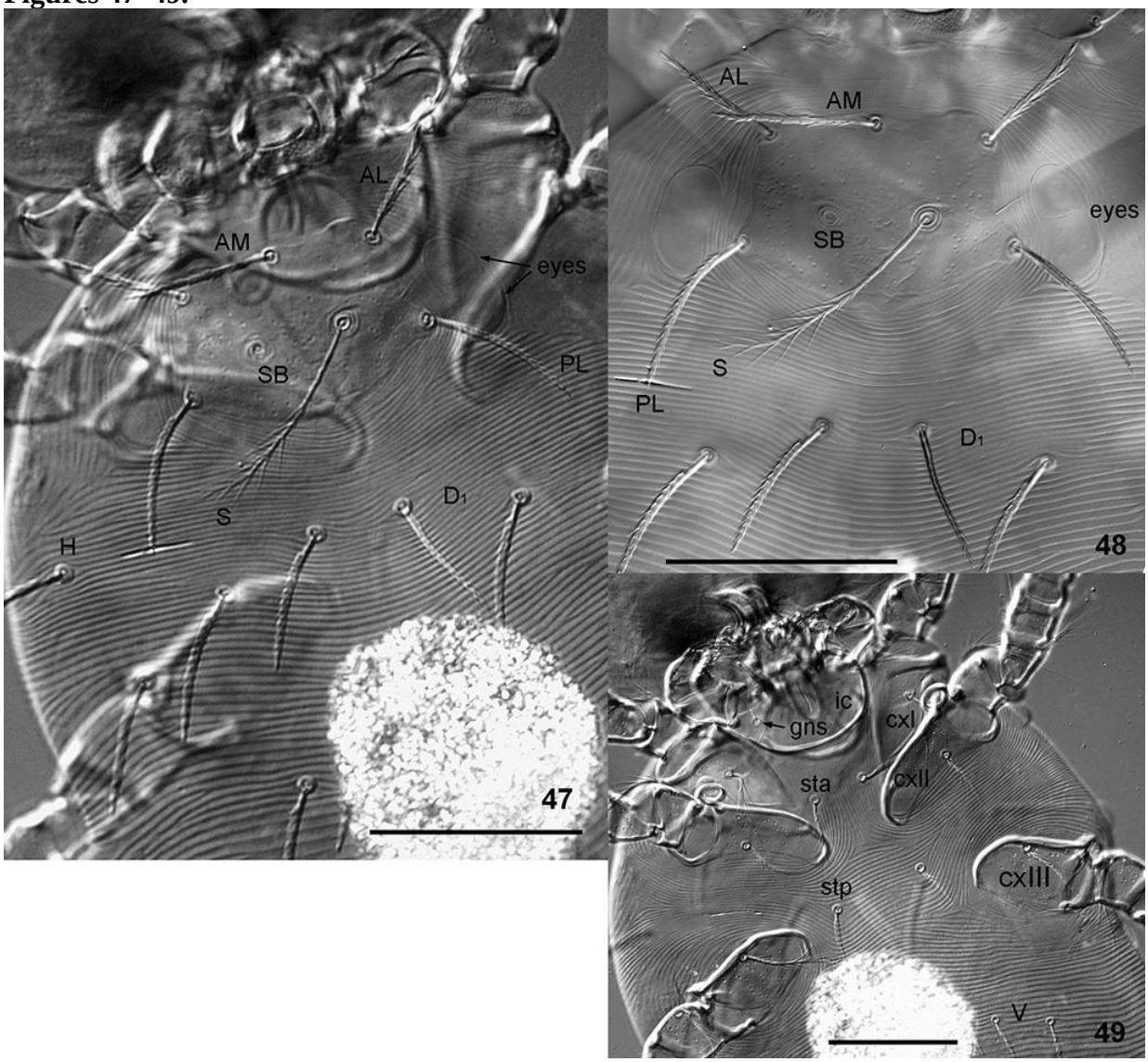
Figures 32–43.



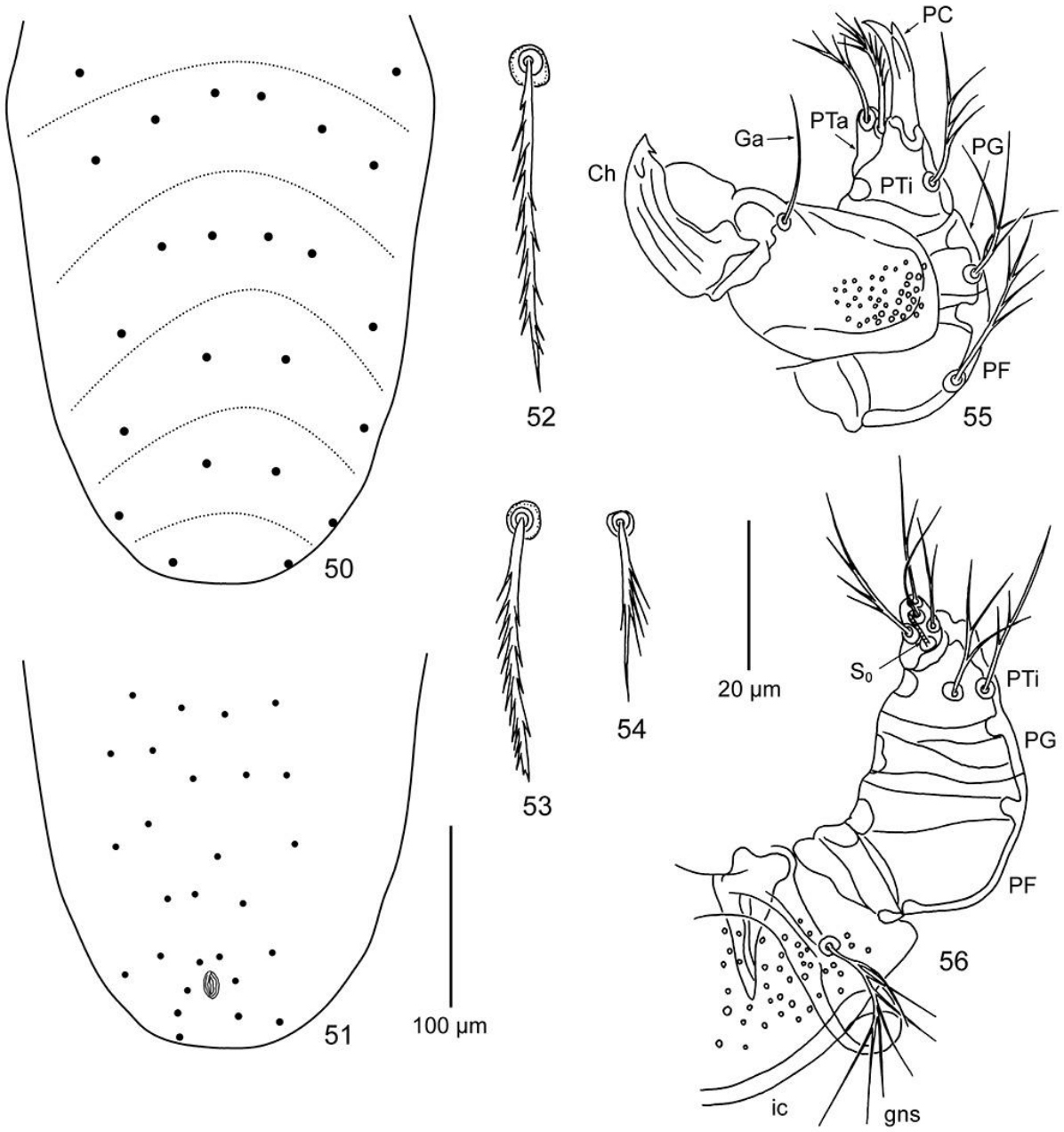
Figures 44–46.



Figures 47–49.



Figures 50–56.



Figures 57–59.